CALIFORNIA STATE BOARD OF HEALTH

MONTHLY BULLETIN

Vol. 8 JUNE, 1913 No. 12

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Published every month at the office of the Board, Sacramento

Entered as second class matter, August 15, 1905, at the post office at Sacramento California, under the Act of Congress of July 16, 1894.

Printed at the State Printing Office, Friend Wm. Richardson, Superintendent

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By courtesy of the University of California the Food and Drug Laboratory and the Hygienic Laboratory are located in University buildings at Berkeley, California.

Address all communications to the

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JUNE BULLETIN.

A REVIEW OF SOME AVAILABLE METHODS OF SEWAGE TREATMENT FOR CALIFORNIA.*

By CHARLES GILMAN HYDE, Consulting Engineer, California State Board of Health.

PRELIMINARY CONSIDERATIONS.

Foreword.

The sewage treatment problem is by no means a simple one. The purification of domestic wastes only; offers the least difficulty; the treatment of mixed wastes (domestic, trade, and street) may occasionally present features of utmost difficulty. Each case is more or less completely a law unto itself. It is folly to suppose, as is so often done, that because town X can dispose of its sewage successfully in some certain fashion, town Y can adopt the same method with a certainty of securing equally satisfactory results. As will be shown forthwith, sewages differ widely in character and composition, not only as between towns, but in a given town as between seasons, days of the week and even hours of the day. The only rational method of attacking the sewage treatment problem for a community wherein sewers are already in operation, is to carefully determine the regimen of sewage flow by measurement and its character by analytical methods. For towns projecting sewerage and sewage disposal works comparisons must be made with other towns having quite similar conditions. There can be no question but that specially trained and experienced sanitary engineers are needed for the design of the more refined and effective works for sewage treatment. The whole subject of sewage disposal is worthy of and demands careful study.

With the exception of a comparatively few places where sewage farming or broad irrigation of sewage has been introduced, almost the only type of sewage purification works to be found in California to-day are septic tanks, so-called, fully "fifty-seven varieties" in all, differing as to shape, relative size, etc. Many of these are operating very indifferently well and some very badly indeed. The general situation shows plainly the need of expert advice to municipalities with respect to general methods and necessary efficiencies from some central advisory authority. To every student of this matter it is clear that this body should be the State Board of Health, which should be furnished with ample funds to develop and maintain a corps of trained and capable sanitary engineers. This has been done with the greatest success and efficiency in Massachusetts for more than twenty years, in Ohio for ten years, and in other states, such as New York and Pennsylvania, during shorter periods of time.

Purpose of article.

It is the purpose of the present article to outline in brief and untechnical terms some of the most available rational processes of sewage treatment adapted and adaptable to California conditions. It is especially hoped to show that there are available processes of treatment of sewage other than by the septic tank, which has been very much over-exploited in this section. Features of design and construction, being peculiarly engineering problems, will not be discussed in detail.

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*Reprinted from the November, 1911, Bulletin of the California State Board of Health.

Character and composition of sewage.

A fundamental characteristic of sewage, and one which bears immediately upon the sewage treatment problem, is that it consists of two very definite and distinct parts, namely, a conveying liquid and suspended solids. Sewage is the water supply of the community—except that portion which is used on lawns, gardens, etc., and which does not reach the sewers—conveying fœcal, bath, kitchen, laundry, industrial, street, and other wastes. The conveying liquid is usually rich in dissolved organic matter, most of which is readily decomposable or putrescible and extremely high in its content of bacteria. The sludge is more resistant in composition, but extremely rich in organic matter, very putrescible and high in its content of bacteria. At the usual velocities obtaining in sewers the solids are kept in suspension, but when the velocity is checked and reduced to a very slow forward motion, as in precipitation basins, septic tanks, etc., these suspended solids tend to settle from the sewage, forming a sludge, and leaving a supernatant, milky, fairly turbid liquid. In this liquid are collodial substances, on the border-line between solution and suspension, which will not settle until changed in character.

Messrs. Kinnicut, Windslow, and Pratt have very clearly exhibited in tabular form the general character of the sewage of an American residential town as respects solid matter, as follows:

Solid matter, 200–800 parts per million.	Inoffensive, mineral, 50 per cent	In solution, 75 per cent. In suspension, 25 per cent.
	Offensive, vegetable and animal, 50 per cent	In solution, 60 per cent. In suspension, 40 per cent.

All sewages are very unstable, and their composition at any time is determined not merely by the character of the initial fresh, raw product, but also by the extent of the changes which have been wrought therein, mainly by the action of bacteria but partly by chemical action. Due to these changes, which arise or set about as soon as sewage is received into the sewers, it is to be remembered that the distance and rate of travel may become important factors determining the state of a sewage when it arrives at the disposal works and defining the optimum period of storage in septic tanks, etc.

The character of a municipal sewage varies with the habits of the people as respects the use and waste of water, with climatic conditions, with the amount and character of trade and industrial wastes, with the infiltration of ground-water, etc. In some communities the wastes from a single large industry, such as a cannery, creamery, tannery, brewery, strawboard factory, wool scouring shop, dyeing and cleaning works, etc., may, during certain hours of the day, predominate over all other wastes, changing the character of the sewage very materially. It must be clear, from a consideration of the action and interaction of these principal governing factors, that the character of sewage must be very different in different communities, and in a given community at different seasons of the year, different days of the week, and even different times during the day. A recognition and determination of these differences are esential to success in a sewage treatment problem. The analytical determination of the character of sewages requires training, experience and equipment. Such work should be done by the State Board of Health for all communities—at any rate for all towns and cities except, perhaps, the largest, which may happen to be provided with their own properly equipped laboratories and trained analysts. It is a striking fact that practically no sewage analyses have been made in California, and virtually nothing is known with respect to the character and composition of the sewages of our municipalities or of the sanitary efficiency of our treatment works.

Disposal by dilution.

Except for those cities and towns situated upon the coast or upon great tidal bodies of water, such as San Francisco Bay, the opportunity for disposal of sewage by dilution is generally lacking in California. Few of our river systems, except perhaps the Sacramento and San Joaquin rivers, yield a sufficiently large and constant discharge to permit of disposing any considerable quantities of sewage therein without creating a nuisance. Experience elsewhere has demonstrated rather definitely that a nuisance will surely be caused if sewage is diluted with less than about twenty volumes of water, while from forty to fifty volumes may in some cases be necessary to certainly prevent a nuisance. Of course, these values refer to low flow, if not to minimum flow, conditions in streams. In the January issue of the Bulletin, Mr. Griswold has discussed the action of self-purification in streams and has presented an outline of the conditions which determine the extent and efficiency of this action. The conditions which may define the term "nuisance" in connection with river pollution are: The formation of deposits of sludge on the banks and in the beds of the streams; the production of turbidity, milkiness, oiliness and discoloration of the water; the formation of gases of decomposition, principally sulphuretted hydrogen, causing very bad odors; the formation from sludge of masses of scum which float upon the water, due to the bubbles of gas contained; the destruction of fish, etc.

But the problem of disposal by dilution is much broader than the mere question of whether, on the one hand, a nuisance will be caused or, on the other, the self-purifying power of the stream will be sufficient to maintain its sightliness and æsthetic character. Of far greater importance are the questions of adaptability to water supply and industrial purposes, the promotion and conservation of the health of residents in the vicinity, and the possibility of indulging in water sports, etc., without undue danger. The rivers of California are of priceless value to the State and its people and should not be made to serve as sewers for the removal of the wastes of an ever-increasing population.

The laws of the State of California with respect to the control of the purity of inland waters are now, thanks to the work of the legislature in its last regular session, quite satisfactory. There are still, however, many things to be accomplished, both from the standpoint of legislative action and from that of administration. It seems clear that broader powers must be given to the State Board of Health together with largely increased funds to provide the machinery for carrying on the work which demands more or less immediate attention.

With respect to the taking of water supplies from streams into which sewage or sewage effluents find their way, a careful review of the situation by sanitary engineers has led to the following fairly well-crystallized conclusions:

(1) No surface waters receiving sewage or the effluents of sewage treatment works are suitable for water supply purposes without purification.

(2) The discharge of crude or of partially purified effluents into such streams must at all points be well below the limit within which self-purification can readily be accomplished.

(3) All supplies of water derived from sewage polluted streams must be purified in accordance with methods adapted to the particular conditions of the stream in question.

Required degree of sewage purification.

From the preceding discussion it will be seen that the required degree of purification, or, in other words, the efficiency of the removal of the polluting matters in sewage, must be determined in any given case from considerations of the amount and character of the sewage, the regimen of the stream, the self-purifying capacity of the stream, the utilization of the stream for water supply purposes, etc. Different methods of sewage treatment naturally yield different efficiencies, and certain methods of treatment may be modified and adjusted to yield different degrees of purification according to requirements.

METHODS OF TREATMENT.

General classification.

The various available known methods of sewage treatment may be classed in three distinct and important groups, as follows:

(*a*) Those which remove more or less of the solids, especially the suspended matters, but from which the effluent is chemically unstable and capable of further decomposition and putrefactive changes. Methods in this class may be called "preliminary" or "preparatory."

(*b*) Those which remove a substantial proportion of the dissolved and suspended mineral and organic matter and which produce an effluent of fairly stable composition requiring only a moderate degree of further oxidation to render wholly stable. These methods may be called "final."

(*c*) Those which destroy the bacteria, especially the pathogenic or disease-producing bacteria, but which in themselves do not effect any material change in the physical or chemical character of the sewage. These methods may be called "disinfection" methods.

When class (*b*) methods are used, it has recently been customary to provide some preliminary treatment in accordance with one or more of the methods in class (*a*). In important cases, especially during the prevalence of epidemics of intestinal diseases, class (*c*) methods may be applied to supplement the work of either or both class (*a*) and (*b*) methods.

"Preliminary" methods of treatment.

(*a*) The various preliminary or preparatory methods of treatment in vogue to-day, named in order of their general efficiency, from the least to the greatest, in the removal of suspended matters, are as follows:

(1) Grit removal.
(2) Screening, coarse and fine.
(3) Plain sedimentation.
(4) Straining or roughing.
(5) Chemical precipitation.
(6) Septic tank processes { In Cameron type septic tanks. / In Imhoff type septic tanks.
(7) Contact beds—single.

"Final" methods of treatment.

(*b*) The various methods of treatment which ordinarily do or may produce effluents of such a stable character as to entitle them to be classed as "final" methods are the following, named in the order of efficiency of removal of organic matter from the least to the greatest:

(8) Contact beds—double.
(9) Trickling, percolating or sprinkling filters.
(10) Intermittent filtration through sand.
(11) Broad irrigation or sewage farming.

Disinfection of sewage.

(*c*) The particular method of disinfection of sewage and sewage filter effluents which is in use to-day in the United States is the following:

(12) Hypochlorite (bleaching powder) disinfection.

(1) Grit removal.

Grit chambers are designed with a view to remove from sewage the coarser suspended mineral matter which settles rapidly, due to its high specific gravity and mass, and such matters only. These materials should be found only in combined sewages which receive street wastes. In Europe the silt and other coarse materials removable by grit chambers or basins are known as "road detritus." Grit chambers are usually unnecessary in works treating domestic sewage. In the treatment of combined sewages they are of value as preliminary to disposal by dilution and as precedent to subsidence of all types, plain, coagulated, and septic.

Grit chambers should be sufficiently large to intercept the heavy mineral matter and yet so small that no significant proportion of organic matter will be deposited. The capacity should as a rule be such that a net period of storage of at least three minutes is allowed, but the forward velocity should not be less than 5 feet per minute.

In some cases where grit chambers have been constructed in California in connection with septic tanks, they have been made so large that violent septic action, accompanied with excessive scum formation, takes place in them. This is, of course, very undesirable. It is apparent that if grit chambers are needed they should be carefully proportioned and arranged in multiple units, both for purposes of cleaning and with a view to maintain a more or less definite period of subsidence notwithstanding changes in rate of sewage flow.

(2) Screening, coarse and fine.

The object of screening is the removal of the coarser suspended matters in sewage. The modern tendency is toward the use of constantly finer screens, mechanically operated. Screens have always been considered of value in connection with sewage pumping works and inverted syphons. More recently it has been discovered that screening may be of substantial advantage in cases where otherwise untreated sewage is disposed of by diluting in water, or where otherwise unprepared sewage is to be applied directly to a final process such as contact beds, percolating filters, intermittent sand filters or sewage farms. Screens may even be of advantage in connection with the septic process, because of the removal thereby of considerable volumes of light materials which might otherwise float on the surface and unduly increase the amount of scum.

The efficiency of the process depends entirely upon the size of mesh or openings through which the sewage is passed. With ordinary hand-cleaned bar screens from 2 to 10 per cent of suspended matter is removed; mechanically operated self-cleaning sieves may remove as much as from 20 to 25 per cent of the suspended matters. The volume of material removed by bar screens from American sewages is from 2.5

to 6.0 cubic feet per million gallons, while with mechanical sieves this quantity may be from 20 to 40 cubic feet. The amount of moisture contained in the screenings from the finer sieves is greater than in material removed by bar screens.

(3) Plain sedimentation.

By means of plain subsidence in properly designed basins it has been attempted at various places in America and Europe to remove from the sewage the suspended materials or sludge, which have been shown to be a most troublesome element in sewage purification. In practice the period of storage in such tanks varies considerably. The earlier plants were constructed on what is known as the fill and draw principle, but most of the later plants are operated on what is known as the continuous flow principle. In the latter type from six to twelve hours probably represents the range in storage period for American sewages. In properly designed basins of this type from 50 to 75 per cent of the suspended matters may be removed and deposited as sludge at the bottom. The remaining 25 to 50 per cent will ordinarily not settle from the sewage in a very extended period, and therefore the prolongation of the period of storage beyond, say, twelve hours is economically inadvisable. The volume of sludge accumulating in American tanks seems to be from 4 to 6 cubic yards per million gallons of sewage treated. This process, while relieving the sewage of a substantial proportion of suspended solids, nevertheless affords in itself no method of disposal of the sludge as does, in a degree, the septic process. The sludge must be removed from the tanks at frequent intervals and must be separately treated. Under the conditions where plain subsidence would be used, it is evident that the sludge can not be disposed of in currents of water because, if this were a possibility, the crude sewage could be disposed of in the same manner without treatment.

Reviewing California conditions, the writer believes that there are but few situations where plain subsidence can be satisfactorily utilized as a process of sewage treatment. These would seem to be—

(1) In connection with disposal by dilution in tidal waters capable of receiving the settled sewage without producing a nuisance, and where the sludge can be taken to sea in vessels, as at Manchester and London, England.

(2) In connection with intermittent sand filtration and sewage farming where areas of fairly coarse material, suitable for sludge beds, are available.

(4) Sewage straining or roughing.

Only a few examples of roughing filters for sewage exist in this country or Europe. When provided, it is with the object, of course, of removing the suspended matters by means of rapid straining. This is done either through beds of coke or through sand beds in filters constructed like the rapid sand or mechanical water filter. Coke beds have not proved successful in actual practice, especially in cold climates. Rapid sand filters produce a volume of wash water, highly charged with the organic or mineral impurities of the sewage, which may amount to from 3 to 10 per cent of the filtrate. Such wash water requires special treatment which is ordinarily very difficult and expensive. No coagulant is used in connection with such straining filters. The process is an expensive one at the best, both as respects construction and operation. The effluent from such works can be made fully equal to, if not better than, the effluent of plain sedimentation basins, from a sanitary point of view. It is believed that this is not an available process under most California conditions.

(5) Chemical precipitation.

The subsidence in basins of suspended solids, by the use of coagulants of various kinds, was an exceedingly popular method of sewage treatment during a period of some twenty to thirty years prior to the introduction of the so-called biological processes about twelve years ago. A very large number of plants was constructed in England during this time, and a few plants were built in America. By the use of chemicals it was attempted to produce at least a clear effluent, free from suspended matters. This was quite possible, but the sludge problem was rendered ever more difficult to solve, and the effluent, while clearer, was scarcely less putrescible than that resulting from plain subsidence. The amount of sludge created by this process is ordinarily fully fifty per cent greater than with plain subsidence. The efficiency of the removal of suspended matters has usually ranged from sixty to ninety-five per cent. This process is primarily available in California only under the conditions first stated above as the field of application of plain subsidence, namely, in connection with disposal by dilution in situations where the sludge can be taken to sea in vessels.

(6) The septic process.

(*a*) *Cameron type septic tanks.* The characteristic processes involved in the action of septic tanks are not at all different from those which have for a long time been relied upon in connection with the disposal of sewage in leaching cesspools, though, perhaps, without recognition and study until the development of the septic tank called attention to them and offered an explanation for the well-known fact that the sludge from domestic wastes accumulated very slowly, if at all, in such chambers. As a definite treatment, adapted to municipal sewages, the septic process dates back some sixteen years. It was then exploited by Donald Cameron of Exeter, England, who achieved remarkable success in the anaerobic (decomposition) treatment of a portion of the sewage of that city. In his experimental tanks the sludge accumulated very slowly and was so thoroughly changed in composition, due to the long continued action of the bacteria (and other organisms), that it became like humus, and in one year amounted to perhaps one fifth, only, of the solids deposited in the tank. The effluent contained about seventy per cent of the organic matter in the raw sewage. These results were so remarkable as to attract the widest attention, and similar experiments were inaugurated in many different places with corresponding success. On the basis of these studies, the septic process was adopted for the treatment of municipal sewage with almost hysterical enthusiasm, not only in England, but on the continent of Europe and in America. In America, especially, the septic tank wave rolled from the Atlantic to the Pacific seaboards, leaving in its wake a huge number and variety of septic tanks. Some of these, well designed and adapted to local conditions, have achieved all that could reasonably be expected of them, but many others have absolutely failed to perform the work which early experiments would indicate as possible. Failures have been due to a variety of causes, perhaps more than any others to ill adaptation to the specific conditions met with in specific cases, and to a general ignorance of the true principles involved in anaerobic sewage treatment. That the process during the past ten years has been over-exploited and that its general efficiency has been greatly exaggerated are apparent to-day, when, in view of many failures, an actual distrust of the process has been brought about. The statement has been widely circulated among laymen that the effluent of septic tanks is quite suitable for drinking purposes, all of the impurities of the sewage being removed thereby. During the past few years the writer has received many inquiries regarding the truth of this statement.

The septic tank process is primarily aimed at the removal of sludge. It is by no means a final process, inasmuch as the effluent is almost invariably somewhat turbid, always extremely putrescible and rich in unstable dissolved organic matter.

A review of the principles and results of operation of the septic tank of the Cameron type would appear to justify the following more important conclusions:

(1) The average removal of suspended solids from the raw sewage by the most successful tanks may vary between thirty-five and eighty-five per cent, averaging perhaps fifty to sixty per cent. At times of active gas formation the septic effluent may contain a larger amount of suspended matter than the entering sewage. As the sludge accumulates in the tank the condition of the effluent, as respects turbidity and suspended matter, is apt to gradually become less satisfactory.

(2) In some tanks the gassification and liquefaction of sludge almost keeps pace with the rate of accumulation, so that a period of several years may elapse between enforced cleanings. In many other cases the tanks require frequent cleaning, say from two to twelve times per year. The volume of sludge digested, *i. e.*, liquefied and gassified, would seem to ordinarily vary between ten and sixty per cent. The average value is certainly not over forty per cent. Septic sludge is normally less offensive than the sludge from plain sedimentation or chemical precipitation tanks.

(3) The period of storage in septic tanks must be carefully adjusted to conditions. Weak sewages seem to require a shorter storage period than strong sewages. Moreover, the condition of the sewage, whether fresh or comparatively stale when delivered to the tank, is a controlling factor. The gross capacities of the tanks which have been apparently well designed and which have operated with more or less success have been equivalent to from eight to forty-eight hours of sewage flow. As a rule, the period should be not be greater than twenty-four hours nor less than twelve hours, except possibly with weak or stale sewages. Multiple units are very desirable in order that the storage period may be controlled to give optimum results.

(4) As compared with fresh settled sewage the septic effluent, especially that resulting from a too-long storage in the tank, is probably more difficult to oxidize in final processes of sewage treatment, such as the trickling filter, contact bed, intermittent sand filter or sewage farm.

(5) The septic process does not seem to afford an efficient means of destruction of pathogenic bacteria. Recent investigations would seem to permit of the conclusion that septic effluents are only less dangerous than crude sewage to the extent of the efficiency of removal of organic matter.

(6) The climatic conditions in California are especially favorable to the septic process and, in fact, to all biological processes of sewage treatment.

It must be recognized that the septic tank, like other engineering works of this nature, can not be a standardized apparatus. It is one which must be carefully proportioned, designed and adapted to the governing conditions of each case. Probably special consideration must be given to details of design in those sections of the State where very high summer temperatures prevail. Matters of design are beyond the scope of this paper.

Federal patents on the septic tank process have been granted to the Cameron Septic Tank Company, and all cities, towns, and institutions in the United States which have constructed septic tanks have been warned of infringement and threatened with suits. The status of this litigation is so familiar to the people of California that further reference to this subject is considered unnecessary here.*

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*The full details of this litigation in California have been previously published in the March, 1910, number of this Bulletin.

(*b*) *Imhoff type tanks.* In recent years very many investigations and experiments, looking to a more successful solution of the sludge problem than is offered by the septic tank, have been under way. In consequence, various schools of workers, holding different views of the problem, have developed. Some of these schools believe that successful sewage treatment is primarily a physical process involving sedimentation and surface contact, while others hold that the bio-chemical actions are of extreme, if not of fundamental, importance. As a matter of fact, there is truth in both points of view; and it is to be expected that in the future the relative value of sedimentation and surface contact, of bacterial action, and of the activities of larger organisms, such as worms, arachnida, etc., will become manifest.

Aside from its lack of efficiency in many cases, objections to the Cameron type septic tank have been raised on the ground that the effluent is too stale and difficult to treat by oxidation processes, that the odor is frequently obnoxious, and that the sludge is not thoroughly digested and is sometimes quite offensive, although, as stated above, not generally so offensive as that from plain and coagulated subsidence.

During the past two or three years there has been developed in the Emscher Valley, in Germany, a type of tank which seems to overcome most, if not all, of the principal objections to the Cameron type of septic tank. This process was suggested by Dr. Imhoff, and has been strongly advocated by the Emscher Drainage Board. The tank is variously known as the Emscher, Ems, Essen, and Imhoff tank.

In brief, the process consists in passing the sewage at a low velocity through comparatively shallow V-shaped tanks, or chambers, whose sides are sufficiently steep so that the deposited solids settle to the bottom of the V, where they pass through suitably arranged slots into a deep chamber below. The period of storage of the main bulk of the sewage is comparatively brief, say two to four hours. The period is so short that septic action does not become established, yet the rate of travel is sufficiently slow so that a substantial proportion of the suspended matter is deposited. The sewage may then be passed to other treatment devices or to points of discharge in watercourses, as the case may be. It will be seen that the sewage does not have a chance to become stale in the tanks nor does it come in contact with decomposing sludge.

In the lower tank, into which the sludge settles through the slots above referred to, a slow digestion takes place through septic and other action. At frequent intervals portions of the thoroughly digested sludge are drawn off from the bottom of the tank by special piping arrangements and fresher sludge takes its place. The sludge, thoroughly rotted by the action of the bacteria, worms, etc., is no longer sticky and greasy, but humus-like. Due to the downward motion of the sludge, caused by drawing off small quantities at frequent intervals, any toxines which may be produced locally by bacterial action, and which would tend to inhibit such action, are apparently distributed and diffused so that bacterial activity is maintained and the maximum amount of solids is liquefied or gassified. The gas is taken from the top of the lower tank through specially arranged pipes or openings. The sludge is either discharged upon special sludge beds of coarse material, where in favorable weather it drains quickly and soon reaches a state permitting of easy removal, or it may be buried in trenches in agricultural land.

The efficiency of this process under American conditions can only be inferred from certain experimental results. The results obtained at Philadelphia during one year of operation of experimental tanks have been very satisfactory. Tanks of this type have been recommended by Messrs. Hering & Fuller of New York City, and are about to be installed for the treatment of the sewage of Atlanta, Ga.

The California climate would undoubtedly be very favorable to this process. In general, this method of treatment promises well, and should be investigated under local conditions. In a short while considerable data for American sewages will be available. It is evident that the proportioning of these tanks, both with relation to the period of storage of the sewage to effect a deposition of the solids and of the sludge to bring about thorough digestion, is a matter of great importance and must be worked out for various climatic conditions as well as different sewages.

The septic process, as carried out either in the Cameron type or in the Emscher type of tank, but especially in the latter, has at present two distinct fields of usefulness: first, it constitutes an effective means of preparation for any final process which can be better conducted with a sewage from which the suspended solids are more or less completely removed; second, it may be employed where disposal by dilution is permissible if the source of unsightly sludge and scum is removed.

(7) Contact beds, single.

All of the methods or processes of treatment which have been previously discussed have been aimed primarily at the separation from the sewage of the suspended matters, from the coarsest to the very finely divided. Only secondarily have chemical changes in the liquid portion of the sewage been intentionally brought about. In contact beds, however, we have a process which not only removes or changes the character of the suspended solids but which purifies the sewage by bio-chemical action. The action is both anaerobic (liquefying and gassifying) and aerobic (oxidizing), principally the latter. The process, in its physical, chemical and biological actions, is exceedingly complex, although the works required for carrying it out are extremely simple.

Briefly stated, a contact bed comprises a water-tight basin from three to four feet in depth, filled with some hard and fairly durable granular material of a uniform size suited to the particular requirements of a given case, or with horizontal layers of slates or slabs laid about two inches apart. Contact beds must be thoroughly underdrained and the distribution of sewage over the surface must be such as to prevent local clogging.

As usually operated, the beds are filled with sewage in from one to two hours, are kept full of sewage from two to three hours, are emptied in from one to two hours, and remain empty for from four to six hours. Of course, deviations from this general regimen are frequent. The rate of operation of single contact beds is generally equivalent to not less than 600,000 gallons per acre per day, and is seldom greater than 1,000,000 gallons. The loss of head is seldom less than four feet nor more than six feet with beds of the depths stated above.

Single contact, *i. e.*, the use of a single set of contact beds, does not usually produce a stable effluent and, therefore, is to be regarded as a preliminary process in accordance with the distinction adopted for the purposes of the present discussion. The purification which may be expected from single contact, as measured by the removal of suspended solids, may vary between sixty and seventy-five per cent, and as measured by the removal of organic matter between fifty and sixty per cent.

Single contact is seldom employed as a preparatory treatment; it is occasionally employed in conjunction with septic tanks or other preparatory treatments as a final process. Such plants are in operation at Plainfield, N. J., and Mansfield, Ohio, and are said to be giving satisfactory results. California climatic conditions are favorable to this process, and there are doubtless some circumstances under which it can be used to advantage. As a general statement, it may be said that the septic process, perhaps especially as conducted in the Emscher tank, is cheaper and gives an almost equally effective preparatory treatment, yielding a greatly improved but putrescible effluent. Although sometimes employed as a final method of treatment, as stated above, it does not appear that contact beds have a great field of usefulness for this purpose. As respects the destruction of pathogenic bacteria, it is believed that contact beds are not more efficient than other processes giving the same efficiency in the removal of organic matter.

(8) Contact beds, double.

Double contact implies the operation of two sets of contact beds arranged in tandem. As a rule, the material in the beds utilized for the second contact is considerably finer than in the first. The process is capable of yielding a non-putrescible effluent, low in suspended matters though somewhat discolored, and one which can be discharged without offense into very small streams. The net rate of operation, referred to the total superficial area of both sets of beds, is seldom greater than 500,000 gallons per acre per day nor less than 300,000 gallons. The process is not as flexible as to rates of operation as are certain others to be later described. A head of from six to ten feet is normally required for this process. The total efficiency, as measured by the removal of suspended solids, has been found to vary from eighty to nearly one hundred per cent; as measured by the removal of organic matter, the efficiency usually ranges between seventy and eighty-five per cent. One very unfavorable feature of contact beds is that they gradually become clogged with resistant organic and mineral matter, so that removal and cleaning of the filling material are required. This is, of course, expensive and is especially undesirable where labor costs are high.

Climatic conditions in California are favorable to this process. It is capable of treating crude sewage, especially that from which the coarser suspended matters have been removed by effective screening. As compared with intermittent sand filters or sewage farming, from the standpoint of efficiency, the process yields distinctly inferior results. As compared with percolating or trickling beds, contact beds are less compact and are more costly. They are, however, less conspicuous, the odor attending the process is less pronounced and they do not breed flies as trickling filters are reported to do. This process may have a field of usefulness in special cases under California conditions.

(9) Trickling, percolating, or sprinkling filters or beds.

Trickling or percolating filters have been gradually evolved through experiments conducted during the past twenty years. For ten years the process has been in practical operation and for four or five years the mode of action has been fairly well understood, and the process has been a demonstrated success under conditions to which it is adapted and where the works have been properly designed. These filters consist essentially of beds of coarse-grained, durable material resting upon some efficient system of underdrains in or on an impervious floor. If above ground, the beds may be surrounded by walls of concrete, by open brick work or by banked-up filling material; if in excavation, the side walls may be vertical, of concrete, brick or stone, or sloped at the angle of repose of earth and paved or concreted. The size of material, the depth of bed and the rate of operation are all interdependent factors and all relate closely to the strength and character of the sewage. It is of fundamental importance that the sewage be sprinkled or deposited on the surface of the beds in thin, thoroughly aerated films. In practice, the depth of bed generally ranges between 4 and 6 feet, the size of material from $\frac{1}{8}$ of an inch or $\frac{1}{2}$ of an inch up to $1\frac{1}{4}$ inch or 4 inches, and the rate of operation from perhaps 1.0 to 2.5 million gallons per acre. The loss of head is rarely less than 8 feet, and it may be considerably more. It is to be observed that these rates of operation are far in excess of any that can be obtained with other final processes of sewage treatment, especially with intermittent sand filters and broad irrigation. Generally speaking, the best results are not secured with the application of crude sewage unless it is especially weak and has been thoroughly screened, but rather with sewages from which a substantial percentage of suspended matter has been removed by preparatory treatment.

This process is wholly one of oxidation, in which absorption, bacterial action and the activities of larger organisms all play a conspicuous part. The effluent of properly designed and operated works is non-putrescible or stable in character, and may be discharged into the smallest streams. The effluent is not clear, but contains humus-like particles which settle rapidly and which in weight are practically equivalent to the weight of solids applied to the filter. In other words, the trickling bed does not accumulate solids as does the contact bed. As measured by the reduction of organic matter, the general efficiency of the process has ranged in England between eighty and ninety-five per cent. In the United States a much lower efficiency has been obtained, both in experimental and in large municipal plants. Nevertheless, the effluent in all cases has generally been stable and thoroughly suitable, after the settlement of suspended matters, to discharge into streams. In respect to the removal of organic matter, this process shows decided superiority over the double contact process.

In California the conditions are generally ideal for this process. It should have a wide field of usefulness, wherever compact plants must be erected to operate at comparatively high rates in more or less thickly settled districts, where sufficient head is available by gravity or pumping and where land would not be available or the conditions right for broad irrigation or sewage farming.

(10) Intermittent sand filtration.

Intermittent sand filtration is by far the best known and most thoroughly studied process of sewage treatment in America. For more than twenty years it has been constantly under investigation by the Massachusetts State Board of Health, both in experimental plants and in municipal plants, on a large scale. Many sewage purification plants of this type are in operation in Massachusetts, Ohio, and other states where suitable materials are naturally available. The process is one of nitrification or oxidation, and seems, in a general way, to epitomize the natural purification which the soil effects of all impurities deposited in a film thereon. As usually carried out, areas of suitably porous soil are selected and the top soil is removed and placed in embankments between beds, making these of a size best adapted to the rate of sewage flow. These beds are underdrained with tiles if the water-table is not naturally low. Where suitable material is not found *in situ,* the beds may be constructed of especially selected and deposited materials, but such construction, of course, increases the cost greatly. In operation, the sewage is applied in rotation rapidly to each bed until each is completely covered to a slight depth. The bed is then allowed to drain slowly and to rest for some time thereafter. Meanwhile, other beds are being dosed, drained and allowed to rest. These filters are very sensitive to long-continued overdosing and to lack of aeration, and will not prove efficient if not carefully dosed, cleaned and rested. A great deal of information is available with reference to these matters, and it is considered entirely unnecessary to refer in detail to them here.

If conducted in suitable soils at proper rates very high efficiency may be obtained with intermittent sand filters. At one plant, at least, in the United States, that at Spencer, Massachusetts, the filter attendant regularly uses the effluent as a drinking water supply. The bacterial purification should be fully 99 per cent under favorable conditions. The removal of organic matter should be fully 95 per cent. The effluent is usually of excellent appearance and free from disagreeable odors. The rate of operation varies very widely, according to the character of applied sewage, the porosity of the soil, the temperature conditions, etc. In general, the rate varies between 40,000 and 100,000 gallons per acre per day. Higher rates may be employed with effluents of efficient preparatory treatment works.

It is not probable that this method of treatment will ever find wide application in California, although here, as for other biological processes, the climate is quite ideal, even in the most elevated districts where such plants would in all likelihood be built. Where gravelly or sandy deposits are to be found and where broad irrigation can not be conveniently resorted to, as for small isolated institutions, hotels, summer resorts, camps, etc., this method of purification could be very advantageously employed. Throughout our mountainous districts are many resorts where this method of treatment could be very easily adopted, thereby protecting in an efficient manner the streams which are now being polluted.

(11) Broad irrigation or sewage farming.

In the process of treatment known as broad irrigation or sewage farming the sewage is utilized for the growth of crops in very much the same manner that water would be. The sewage has, however, some slight fertilizing value. In principle this method is not essentially different from intermittent sand filtration, but it is usually conducted at rates from one tenth to one twentieth as great as those employed with intermittent sand filters. It is possible to dispose of sewage by broad irrigation at rates varying from 2,000 to 10,000 gallons per acre per day, depending upon the character of the sewage, the kind of preparatory treatment which it has received and the character of the soil. As with intermittent sand filters, higher rates of dosing and better results are generally to be obtained with sewages from which the suspended matters have been in part removed by some preliminary treatment. Heavy soils are not naturally adapted to this method of sewage treatment, but they can be utilized if sufficient area is provided so that the rate of application shall be suitably low. The efficiency of treatment, measured by the removal of suspended solids, organic matter and bacteria may, under favorable conditions be very high indeed, perhaps fully as high as with intermittent sand filtration, which yields effluents of greater purity than any other method thus far discussed. In England an extended experience with broad irrigation shows that if the land is naturally unsuited to this treatment, and if the rate of application is too great or the farms improperly manipulated, high efficiencies can not be obtained. In France and Germany very satisfactory results have been obtained on the extremely large sewage farms operating on the sewage from the cities of Paris and Berlin, respectively. Few, if any, data showing the efficiency of sewage farming in the United States are available.

There can be no question but that in an arid or semi-arid district, where soil conditions are suitable and where lands are available, the disposal of sewage by irrigation is the most logical method which can be employed. It would seem to be a criminal waste to discharge sewage into streams or into the ocean when adjacent lands are suffering from lack of moisture. Moreover, the pollution of the streams whose purity would otherwise be preserved is a feature worthy of careful consideration.

In the rainy season it is specially important that sewage farming be carefully conducted, in order that the sewage shall be thoroughly purified and at the same time that the land shall not be super-saturated. It must be impressed upon the municipalities utilizing this method of sewage treatment that sanitary efficiency rather than financial success is to be primarily sought.

In California the sewage of a number of communities is being successfully treated by broad irrigation, both on municipally owned and on privately owned areas. At some places, notably Fresno, considerable competition in securing rights to the use of sewage for irrigation has developed on the part of private landholders.

(12) Disinfection of sewage or effluents from sewage treatment works.

During the past few years a great deal of attention has been devoted to the problem of the treatment of water and sewage to effect the removal of bacterial contamination, especially contamination by disease germs. Various sterilizing or disinfecting agents have been investigated, with the result that all have been found either too difficult or too costly to apply, with the exception of certain salts of copper and certain chlorine compounds. Of these, for most conditions, the hypochlorite of calcium (bleaching powder) has been found to be cheapest and most efficient, although sodium hypochlorite, electrolytically prepared, may be favorable in very large plants under expert supervision in localities where electric power is very cheap. Carefully conducted experiments at various places have demonstrated clearly that the great bulk of dangerous bacteria can be removed from crude sewage or effluents from sewage treatment works at a very moderate expense, especially for the latter. It is scarcely to be expected that disinfection will be found necessary for effluents from intermittent sand filters or sewage farms, where the bacterial efficiency is already very high. But where effluents from preparatory treatment or rapidly-operated final treatment works, such as contact beds and trickling filters, are discharged into watercourses from which water supplies are derived, or into tidal estuaries from which shellfish are being taken for the markets, it appears that disinfection has a distinct field of usefulness. It is apparent that disinfection is especially necessary when epidemics of intestinal, waterborne diseases prevail in any community disposing of its partially purified or crude sewage in steams utilized for water supply purposes.

SOME GOOD GENERAL REFERENCES ON THE SUBJECT OF SEWAGE TREATMENT.

Text-books.

Sewage Disposal, by Kinnicutt, Winslow and Pratt, New York, 1910.

Principles of Sewage Treatment, by Dr. Dunbar, London and Philadelphia, 1908.

The Design, Construction and Maintenance of Sewage Disposal Works, by H. P. Raikes, London, 1908.

The Purification of Sewage and Water, by W. J. Dibdin, London and New York, 1903.

Recent Improvements in Methods for the Biological Treatment of Sewage, by W. J. Dibdin, London, 1907.

Sewage and the Bacterial Purification of Sewage, by S. Rideal, London and New York, 1906.

The Sewage Problem, by A. J. Martin, London and New York, 1905.

The Purification of Sewage, by S. Barwise, London, 1904.

Reports.

Annual Reports, Massachusetts State Board of Health, since 1890.

Annual Reports, Ohio State Board of Health, since 1900.

Report on an Investigation of Water and Sewage Purification Plants in Ohio, State Board of Health, Columbus, Ohio, 1908.

Report on Sewage Purification at Columbus, Ohio, by G. A. Johnson, Columbus, 1905.

Reports Royal Commission on Sewage Disposal, London, 1902–1908.

Papers.

Contributions from the Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology, Vols. I–V, 1905–1910.

The Disinfection of Sewage and Sewage Filter Effluents, by E. B. Phelps, U. S. Geological Survey, Water Supply Paper, No. 229, 1909.

The Disinfection of Sewage and Sewage Filter Effluents, by E. B. Phelps, Journal of the Association of Engineering Societies, Vol. XLVI, January, 1911.

A New Method of Treating Sewage, by Dr. Imhoff, Surveyor and Municipal County Engineer, May 21, 1909.

Some Recent Progress in Sewage Disposal, by Rudolph Hering, American Journal of Public Hygiene, Vol. XX, November, 1910.

Various articles in Engineering News, Engineering Record, etc.

SEPTIC TANKS.

By N. D. Baker, Junior Member American Society of Civil Engineers.

Purpose.

The septic process is used for three reasons:

1. To get the sludge or solids out of the sewage so that the liquid part of it may be disposed of by some other means. If this is to be done by broad irrigation or by filtration through sand beds it is essential that the sludge be taken out first to prevent clogging of the distributing ditches or of the filters, as the case may be. The sludge might be removed by plain sedimentation, chemical precipitation, or to some extent by screening, but this leads up to the second purpose of the septic tank; which is—

2. To destroy the sludge. In using any of the other three methods of sludge removal, the great question of sludge *disposal* remains unsolved. The sludge has been taken out but not destroyed. The properly operated septic tank removes a considerable portion of the sludge and also destroys or "digests" a considerable portion.

3. Another purpose of the septic process is to carry the sewage through the first stages of putrefaction, and to render it less likely to create a nuisance when discharged into streams or other bodies of water or on land. It has been estimated that a stream will receive twice as much septic sewage as it will take raw sewage before the point of pollution is reached which will cause a nuisance.

Theory of a Septic Tank.

The septic process differs from others in that here the organic matter in the solids is broken down to simpler substances by the putrefactive or liquefying bacteria. These low forms of vegetable life work best in absence of air, and they use up the dissolved oxygen in the sewage so that the action, if complete, would give an effluent which would contain *no* dissolved oxygen. After these (anaerobic) bacteria have done their work, the sewage needs to have oxygen introduced so that the (aerobic) oxygen-using bacteria may perform their work of oxidization. It is by the activity of these aerobic or nitrifying bacteria that the products of anaerobic action are oxidized and the resulting condition of the sewage rendered stable, *i. e.,* incapable of further putrefaction.

Design and Operation.

Probably in no other branch of engineering work is there a wider range of variation than in the design of septic tanks. The chief objects of design should be: to get a sufficiently long storage of the sewage to complete the septic action and still not have it too long; and to enforce a uniformly slow and diffused flow through the tank so that there will be no parts of it where the sewage remains stagnant. Also to properly proportion the tank so that the surface area shall be sufficient for mat formation. In some tanks series of baffles are introduced to insure uniform flow. In some of these the baffles are vertical, let down from the top and built up from the bottom, while in others the baffles extend into the tank from the sides. Experience indicates that the use of baffles elsewhere than at the extreme end of the tanks is not to be encouraged.

Size.—The size should be sufficient to hold the flow for the period of storage desired. In different designs this varies from twelve to forty-eight hours. Perhaps eighteen hours' flow is a good average to use, but the period of storage should be adapted to the condition and character of the sewage. Many of the tanks now in use are rectangular, but there have also been designs made for circular tanks in which the sewage is taken in at the center and discharged around the circumference. (Ref., Engineering Record, vol. 60, page 249.)

Area.—Heretofore this point has not been emphasized, but it is important that there be sufficient area for mat formation. This varies with the total solids in the sewage, and also directly with the number of persons connected with the system. If the area is not sufficient, as might be the case where the flow per capita is small, there will be a continued accumulation of sludge until it gets so thick that the tank has to be cleaned and started again. In tanks of this kind one of the purposes of the septic tank is defeated, for the tank only removes the sludge and does not destroy it. In tanks of good design the surface area varies from one half to one square foot or more per person. The first figure is hardly large enough.

Roofs.—The question of roofing a septic tank has aroused some discussion. On the one hand it is claimed that since it is a bacterial process and since bacteria develop and work best in the dark, a roof is necessary to shut out the light. Against this it may be said that after the ''mat'' is formed on the tank it shuts out the light as effectually as a roof. Again, some engineers think an air-tight roof or covering is essential to foster the anaerobic bacterial action. The same answer is applicable here as was given above; that the mat, once formed, is a seal against air as well as light. In fact, there are many successful tanks which are not tightly covered. The best argument in favor of roofs is that the wind tends to break up the mat and prevent its formation in the early stages.

Aeration.—Because the action inside the tank is essentially an anaerobic one, the inflow should be so arranged that as little air as possible is carried in with the sewage. At the outflow pipes provision ought to be made for aerating the effluent. This may be done by making it pass over weirs in thin sheets, or pass upward through vertical pipes and over the edges, falling in a circular sheet. Other devices are used—throwing the sewage through the air in a spray and pumping air through it.

What Should and Should Not Be Expected of a Septic Tank.

A properly designed and operated septic tank should give an effluent containing very little solid matter in suspension, and that only in finely divided particles. Unfortunately this idea is seldom realized. The effluent will still be putrescible and offensive, and may (and very likely will) cause to some extent a nuisance unless properly handled while being further purified.

The bacterial action should destroy all but the mineral ash of the sludge, and the tank ought not to have to be cleaned oftener than once in several tanks. Here again the idea is frequently far from realized. Tanks cleaned every month can certainly not be considered successful.

The mat forms on the surface after a week or more and becomes thicker until the tank reaches a condition of equilibrium. The mat is usually 12 to 18 inches thick at this time, although one case was called to my attention where it continued to grow until it occupied a large proportion of the tank and had to be removed. This was an instance of too small a surface area.

The septic process is only a *preliminary* treatment and can be regarded as nothing more. The effluent is not stable. There is little evidence to prove that pathogenic bacteria do not survive the septic process in sufficient numbers to render the effluent dangerous without further treatment; in fact, there is every reason to believe that such effluents are distinctly dangerous from the standpoint of infection with disease germs.

Limitations.—In applying the septic process of sewage disposal to industrial wastes, each particular problem must be considered by itself. It is largely a problem for the chemist to determine what the sewage contains and what effect, if any, it will have on bacterial action. Through the Santa Clara and San Joaquin valleys the cannery wastes present a special problem. Sometimes these contain large quantities of lye used for peeling fruit. It is probable that this lye would act as a disinfectant in the sewage and deter or entirely prevent septic action in the tanks. At other places there are winery wastes and wastes from tanneries, dye works, pickle factories, paper mills, iron foundries, woolen mills and other establishments, each of which presents its own particular problem and must be dealt with accordingly. Very often it is more desirable to keep such wastes out of the main sewers and dispose of them independently.

Another point of note is that to lend itself readily to septic treatment, sewage should not be too dilute. In any method of treatment it is only economy to treat as small a quantity as possible, since septic treatment depends on bacterial growth in the sewage.

Wherever septic disposal is used the storm drains ought to be in a separate system from the domestic sewers. Sometimes it is desirable to let the first "run-off" from the streets after a "dry spell" go into the domestic sewers for purification treatment, for it sometimes carries considerable organic matter, but after the streets are washed clean this should no longer be done. In some cities this is provided for by connections between the storm drains and domestic sewer mains which are opened for a short time when rain begins to fall. If such practice obtains, the tanks should be especially designed and operated to meet such conditions.

Treatment of Septic Effluent.

To complete the purification of sewage, the effluent of septic tanks must be subjected to a final process in which the nitrifying or aerobic bacteria oxidize the products of the anaerobic action.

Sometimes this can be done at a profit by using the water for irrigation. For reasons that will be apparent it ought not be used for berries and soft skinned fruits nor for vegetables, such as celery, radishes, lettuce and those that are to be eaten raw. Where space is too limited for disposal by irrigation, contact beds or sprinkling filters are sometimes made use of. The materials used are broken stone, brick, coke, cinders, etc., the idea being to have a large area exposed to the sewage.

The beds are filled and drained alternately at intervals of eight to twelve hours. During the period when the filter is empty cultures of aerobes develop on the surface, oxidizing the material left there from the sewage. The purification depends on a bacterial process and the action is that of both aerobic and anaerobic forms which oxidize the organic matter and render it non-putrescible. These filters need not be expensive. They require some attention, but various patent automatic devices for regulating them are in use which serve to minimize the work of running the filter as well as to remove the personal equation of the attendant.

The use of slate beds is attracting some attention. These are made up of horizontal slabs of slate held apart at the ends by stone blocks. For the slate beds it is claimed that worms develop on the slates which work over the sludge and reduce it to harmless and inoffensive humus. The slate beds, like the contact filters, are dosed and rested alternately, multiple beds being necessary for this reason. A very good account of slate beds can be found in the Engineering Record, vol. 60, page 511.

Data on Some California Septic Tanks.

Fresno.—Population (1910), 24,900. Average sewage flow 6 to 7 cubic feet per second; 4,000,000 gallons per day. Concrete tanks; eight tanks each 36 by 90 by 6½ feet. Total capacity, 1,260,000 gallons. Storage about 7 hours. Effluent used for irrigation. Area surface, 26,000 square feet, or 1 square foot per person. City engineer, Mr. C. P. Jenson. Tank designed by Mr. Geo. L. Hoxie, formerly city engineer. The sludge has to be removed every few weeks.

Colusa.—Population (1910), 1,580. Reinforced concrete tanks; 2 units each 180 by 6 by 7½ feet. Total capacity, 50,000 gallons. Total area, 2,160 square feet, or 1.4 square feet per person. Designed and built by Mr. J. W. Kearth, city engineer.

Selma.—Population (1910), 1,750. One concrete tank, 40 by 100 by 8 feet. Capacity, 240,000 gallons. Area, 4,000 square feet, or 1.6 square feet per person. Estimated storage, 24 hours. Designed and built by Mr. Schaffer, city engineer.

Hanford.—Population (1910), 4,830. Tank designed by Dr. Musgrave, City Health Officer. Timber lined tank 65 by 24 by 7 feet. Capacity, 80,000 gallons. Area, 1,560 square feet, or .26 square foot per person. Estimated storage, 5 to 8 hours. Septic action incomplete. Effluent carries solid particles. Used for irrigation.

Corning.—Small private tank owned by Hotel Maywood.

Eldridge.—Population, 1,000. Wooden tank 150 by 15 by 10 feet, covered. Capacity, 155,000 gallons. Area, 2,250 square feet, or 2¼ square feet per person. *Storage; estimated 24 hours. Effluent very clear, but rather offensive.

Willows.—Population (1910), 1,140. Settling tank of concrete, open, 33 by 10 by 10 feet, designed for sedimentation: depth of 2½ feet. Capacity, 6,200 gallons. Area, 330 square feet, or .16 square foot per person. Not designed for septic treatment. Effluent clear and free from solids. Used for 3 years, and very small sludge deposit.

Sebastopol.—Population (1910), 1,230. Timber lined tank 160 by 15 by 6 feet, covered. Capacity, 100,000 gallons. Area, 2,400 square feet, or 1.6 square feet per person. Storage, estimated 10 to 15 hours.

Santa Rosa.—Population (1910), 7,820. Roofed, unlined tank, 250 by 27 feet at surface, 8 feet deep; side slopes 1 to 1. Capacity, 300,000 gallons. Area, 6,750 square feet, or 1.1 square feet per person. Estimated storage, 4 hours. Septic action incomplete.

Bakersfield.—Population (1910), 12,700. City engineer, Mr. Buffington. Circular concrete tank designed by Mr. Buffington, 200 feet diameter, 8 feet deep. Capacity, storage, 16 hours.

Redondo Beach.—Population (1910), 2,940. City engineer, Mr. A. A. Henderson. septic tank designed by Olmstead and Gillelen, Wright & Callender building, Los Angeles. Tank 160 by 50 by 7½ feet; reinforced concrete arched roof. Capacity, 450,000 gallons.

Long Beach.—Population (1910), 17,800. Timber lined tank, two units, each 610 by 6 by 6 feet. Capacity, 44,000 cubic feet—330,000 gallons. Area of surface, 7,300 square feet, or .37 square foot per person.

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*Measured flow October, 1909—77,000 gallons, septic period 48 hours. Action incomplete.

Sawtelle, Soldiers' Home.—Total population, 3,000. Two tanks, independent, but same size and same flow. Each tank 70 by 20 by 8 feet. Capacity, each 82,500 gallons. Total capacity, 165,000 gallons. Estimated storage 6 hours. Area of surface (total for both) 2,800 square feet, or .9 square foot per person. Tanks doing good work.

Pomona.—Population (1910), 10,200. Tank 45 by 24 by 8 feet, cement lined. Capacity, 65,000 gallons. Flow estimated at 75 gallons per capita, 750,000 gallons. Estimated storage about 2 or 3 hours. Area, 1,100 square feet, or .1 square foot per person. Tank too small, and has to have mat removed frequently.

Patton State Hospital.—About 1,500 inmates. Concrete septic tank. Two units; only one in use. Each unit 116 by 20 by 7½ feet. Capacity, 131,000 gallons. Estimated storage 10 hours. Area of surface, 2,200 square feet, or 1.5 square feet per person.

References.

Sewage Treatment. Venable. Sewage. Rideal. Pub., Wiley & Sons, New York.

Sewage. Folwell. Pub., Wiley & Sons, New York.

The Practical Operation of Sewage Purification Plants. John W. Alvord.

Annual Reports of Massachusetts and Ohio State Boards of Health. 1908–09.

Septic Tank Disposal: Slate Beds: Sludge Disposal: Crops on Sewage Beds: Engineering Record, vol. 60, pages 37, 77, 212, 249, 287, 351, 580. Journal of the Association of Engineering Societies, vol. 34, page 33. Engineering News, vol. 62, pages 196, 251. Municipal Engineering, vol. 37, page 20. Municipal Engineer, vol. 37, page 105. Engineering News, vol. 62, page 167. Engineering News, vol. 62, page 101. Manufacturing Wastes. Municipal Engineer, vol. 37, pages 80, 106, 364. Engineering Record, vol. 60, pages 71, 157, 420, 580, 667, 681, and 704.

Sewage Disposal in America. Transaction Amer. Soc. C. E., vol. 54, pages 147, 182.

Septic Tank Patents. Municipal Engineer, vol. 35, page 290.

Engineering Record, vol. 58, pages 223, 253.

In addition to the subjects specifically mentioned above, references include statements relative to Standards of Purification; Sewage Testing; The Cost of Disposal; Disinfection of Sewage; Stream Pollution; National and State Control of the Problem.

RESIDENTIAL SEWAGE DISPOSAL PLANTS.

The following quotations from an excellent article on residential sewage disposal plants by Mr. R. Winthrop Pratt* have been included as illustrating the application of the data outlined by Mr. Baker as the basis by constructing successful septic tank plants for disposing of sewage:

"A plant designed according to the above mentioned principles may be described somewhat as follows: The outflowing sewage from the house is delivered into a settling basin of sufficient size and of suitable design to afford opportunity for the sedimentation of the solid matter and the rise of the grease. This basin or tank contains a constant volume which approximately should equal one or two days' flow of sewage. The inlets and outlets should be so arranged that neither the scum at the top nor the sludge at the bottom is disturbed as the sewage passes through it. The matter deposited in the bottom of the tank becomes partially reduced and passes away in the form of liquid or gas. There will be, however, a certain accumulation which must be cleaned out occasionally, probably not oftener than once a year. The tank should be ventilated through the main soil pipe of the house in the same way in which modern sanitary sewer systems are ventilated.

The clarified liquid overflowing from this tank passes into a second one adjacent thereto, called the dosing tank. Herein is placed an automatic siphon or other controlling device which holds back the flow until the sewage has reached a certain depth, at which time the entire contents of the dosing tank are discharged very rapidly. The discharge completed, the apparatus automatically prevents further outflow until the tank becomes again full. This tank serves to apply the sewage to the filter, sub-surface disposal system, or other means for final purification, to which the capacity or 'dose' must bear a certain relation in order that the sewage be properly distributed.

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*Copied without the illustrations from pp. 231-235 of the July, 1911, issue of the Monthly Bulletin, Ohio State Board of Health. Mr. R. Winthrop Pratt is Chief Engineer, Ohio State Board of Health.

Such distribution is essential for the reason that, if the sewage is allowed to pass on to the filter or into the 'absorption system' in the same irregular way that it leaves the house, the filtering material will be constantly saturated in places and hence become clogged and foul. In other words, the filtering material must be kept clean by allowing the air to frequently penetrate it.

The disposal of the clarified sewage by open filters and by broad irrigation is identical, in principle, with the corresponding methods for city plants and need not be described here. Of course, these can be used only where ample land is available; and they are not suitable for built-up districts, but rather for isolated houses. In any case, these methods involve exposing the unpurified sewage to the air and are therefore less desirable than a sub-surface system. If, however, one wishes to construct a filter bed in a concrete chamber beneath the ground, this can be satisfactorily done, though somewhat expensive, in close proximity to residences.

The sub-surface disposal system is composed of lines of three-, four- or six-inch agricultural drain tile or vitrified pipe with open joints, laid level or nearly so, within one or two feet of the surface of the ground. These are called absorption or distribution pipes. Their total length is determined primarily by the porosity of the soil in which they are placed and varies for a family of five or six, from 100 to 600 feet. In clayey soils it is necessary to thoroughly underdrain the land at a depth of 3 or 4 feet in order to render the soil dry enough to absorb the sewage, and in addition it is desirable to surround the tile with gravel, cinders or porous material. There should be, of course, no opportunity for sewage to pass directly from the absorption pipe into any of the underdrains. As mentioned above, the cubical contents of the absorption system should have a certain relation to the dosing tank in order that the sewage may be properly distributed. It is often convenient, furthermore, to divide the system into two or three portions in order that the flow may be changed from one to the other every few weeks.

There will doubtless be a certain accumulation of finely divided solid matter in the tile which may make necessary their relaying after a period of years. This, however, is a matter of small importance. The system can be placed at any convenient point and is often installed underneath the lawn or vegetable garden without in any way showing evidences of its existence, except by assisting in the growth of vegetation.

While the general principles of the design of municipal sewage purification plants apply also to residential plants, yet there are several practical differences which should be borne in mind.

In the first place the sewage from individual houses is extremely fresh and there is no opportunity for the mechanical breaking up of the larger suspended particles as is the case when sewage flows for miles in a city sewer. Then there are extreme fluctuations in the rate of flow in the case of the single house, as compared to the more regular discharge from a municipality. For instance, there is rarely any flow during the night, and the flow during the day comes in sudden rushes.

The small actual size of a house sewage tank, although it may be large from the standpoint of 'hours of storage,' may permit a sudden inrush of sewage to stir up the entire contents, thus carrying out some solid matter and causing the filters or the sub-surface system to clog. The above mentioned facts show the necessity of designing both tanks and finishing treatment on a more liberal per capita basis than is required with municipal plants.

Finally, residential plants are intended to be more automatic than municipal plants, and rarely receive regular attention, and they must of necessity, be located much nearer to dwellings than city plants. It is necessary, therefore, to exercise much more care in design in order that no work need be done on the plant oftener than once a year, although it should be inspected every few months. Also the design should be such that the plant will create no odors even though within a few feet of a residence.

Relative to the cost of building an efficient residential sewage disposal plant for a family of five or six, this will vary greatly according to the local cost of material and labor and the character of the ground in which it is to be placed. The usual tanks with sub-surface absorption system should be built in porous ground for $100 to $150; and in clay soil for $250 to $300. A plant including a covered sand filter may cost $500.''

REPORT OF THE BUREAU OF ADMINISTRATION FOR MAY, 1913.

JOHN F. LEINEN, Director.

Division of Sewage Disposal and Water Supplies.

During the month a formal application for sewage disposal in inland waters was received from the Newcastle Sanitary District, Newcastle, Placer County, California.

The Board's Consulting Engineer held several important conferences relative to sewerage and sewage disposal problems of communities, as follows: On May 3d and 5th, with Mr. C. E. Grunsky, consulting engineer, relative to the disposal of the sewage of Stockton; on May 7th, with Messrs. Bliss and Givan and with Dr. Snow, relative to the disposal of the sewage of Sacramento; on May 14th, with Mr. M. C. Polk, city engineer of Chico, relative to the treatment of the sewage of that place; on May 29th, with Mr. Knowles, bridge engineer of the Western Pacific Railroad, with reference to the sewerage and sewage disposal of Portola.

The consulting engineer of the Board visited Auburn and Newcastle on May 8th, held conferences with the local officials and made special examinations into the problems of sewage disposal.

A detailed report upon the sewerage and sewage disposal problem of Orange was completed and submitted to the Board for action. The preparation of a report upon the disposal of the sewage of the Newcastle Sanitary District was practically completed and will be submitted to the Board early in June. Work upon the preparation of a tentative report dealing with the Los Angeles sewage disposal situation was begun. The plans and specifications for the new and improved sewerage and sewage disposal works for Los Gatos, prepared by Mr. F. A. Nikirk, city engineer, were also reviewed. A special examination of sand samples from a proposed temporary sewage disposal area for the city of Stockton was made by Mr. H. B. Foster in the office of the consulting engineer. In this connection it might be said that similar studies have recently been conducted on soils of lands used for sewage disposal at Orange and Orland, and are proposed for Chico.

REPORT OF BUREAU OF VITAL STATISTICS.*

GEORGE D. LESLIE, Director.

State Totals and Annual Rates.—The following table shows for California as a whole the birth, death and marriage totals for the current and preceding months in comparison with those for the corresponding months of last year, as well as the annual rates per 1,000 population represented by the totals for the current and preceding months. The rates are based on an estimated midyear population of 2,671,491 for California in 1913, the estimate having been made by the Census Bureau method with slight modifications.

Birth, Death and Marriage Totals, with Annual Rates per 1,000 Population for Current and Preceding Months for California: April.

Month.	Monthly total.		Annual rate per 1,000 population: 1913.
	1913.	1912.	
April—			
Births	3,484	3,180	15.9
Deaths	3,235	3,038	14.7
Marriages	2,446	2,365	11.1
March—			
Births	3,488	3,306	15.4
Deaths	3,330	3,363	14.7
Marriages	2,167	1,816	9.6

The birth, death and marriage totals for April were greater in 1913 than in 1912, the gain being particularly great in the case of births.

County Totals.—The first table which follows below shows the monthly birth, death and marriage totals for the principal counties of the State, the list being limited to counties having a population of at least 25,000 according to the Federal Census of 1910. Totals are also shown for San Francisco and the other bay counties (Alameda, Contra Costa, Marin, and San Mateo), as well as for Los Angeles and Orange counties together.

City Totals.—The second of the following tables gives the birth and death totals for the principal freeholders' charter cities, the list including all chartered cities with a census population of at least 15,000 in 1910. Totals are given likewise for San Francisco in comparison with Oakland, Alameda, and Berkeley, the three cities adjoining one another on the east shore of San Francisco Bay, as well as for Los Angeles in comparison with neighboring chartered cities (Long Beach, Pasadena, Pomona, and Santa Monica).

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*NOTE.—The present report is for the month preceding, but one. This order must be followed hereafter because of the publication of the Bulletin during the early part of the month, before the tabulation of records for the preceding month is completed.

Birth, Death and Marriage Totals, for Principal Counties: April.

County.	April, 1913.		
	Births.	Deaths.	Marriages.
California	3,484	3,235	2,446
Counties of more than 25,000 population (1910):			
Alameda	268	297	218
Butte	40	43	12
Contra Costa	48	42	17
Fresno	158	80	86
Humboldt	33	35	18
Kern	45	44	27
Los Angeles	1,004	835	573
Marin	23	21	84
Orange	50	43	115
Riverside	37	56	36
Sacramento	129	91	96
San Bernardino	71	81	48
San Diego	124	119	125
San Francisco	642	611	490
San Joaquin	41	79	58
San Mateo	45	24	36
Santa Barbara	57	36	21
Santa Clara	96	125	78
Santa Cruz	25	26	17
Solano	17	42	10
Sonoma	68	64	24
Tulare	45	36	27
Selected groups:			
San Francisco and other bay counties	1,026	995	845
Los Angeles and Orange counties	1,054	878	688

Birth and Death Totals, for Principal Cities: April.

City.	April, 1913.	
	Births.	Deaths.
Freeholders' charter cities	2,215	1,955
Cities of more than 15,000 population (1910):		
Alameda	25	28
Berkeley	34	36
Fresno	60	25
Long Beach	34	29
Los Angeles	691	528
Oakland	186	173
Pasadena	58	41
Riverside	15	22
Sacramento	99	76
San Diego	90	90
San Francisco	642	611
San Jose	44	40
Stockton	20	39
Selected groups:		
San Francisco	642	611
Oakland, Alameda and Berkeley	245	237
Totals, bay cities	887	848
Los Angeles	691	528
Neighboring cities	123	103
Totals	814	631

Causes of Death.—The following table shows the classification of deaths in California for the current month, in comparison with the preceding month:

Deaths from Certain Principal Causes, with Proportion per 1,000 Total Deaths, for Current and Preceding Month, for California: April.

Cause of death.	Deaths: April.	Proportion per 1,000.	
		April.	March.
ALL CAUSES	3,235	1,000.0	1,000.0
Typhoid fever	23	7.1	7.2
Malarial fever	4	1.2	----------
Smallpox	7	0.3	----------
Measles	29	9.0	2.4
Scarlet fever	8	2.5	0.3
Whooping-cough	9	2.8	3.6
Diphtheria and croup	22	6.8	5.1
Influenza	22	6.8	8.1
Other epidemic diseases	10	3.1	5.1
Tuberculosis of lungs	408	126.1	126.7
Tuberculosis of other organs	85	26.3	23.4
Cancer	238	73.6	62.8
Other general diseases	142	43.9	45.4
Meningitis	49	15.1	13.5
Other diseases of nervous system	288	89.0	90.4
Diseases of circulatory system	486	150.2	175.1
Pneumonia and broncho-pneumonia	232	71.7	93.1
Other diseases of respiratory system	57	17.6	24.3
Diarrhea and entritis, under 2 years	76	23.5	13.5
Diarrhea and enteritis, 2 years and over	31	9.6	7.2
Other diseases of digestive system	164	50.7	49.0
Bright's disease and nephritis	209	64.6	65.2
Childbirth	41	12.7	7.8
Diseases of early infancy	119	36.8	37.8
Suicide	68	21.0	20.4
Other violence	261	80.7	69.1
All other causes	153	47.3	43.8

In April there were 493 deaths, or 15.2 per cent of all, from various forms of tuberculosis and 486, or 15.0 per cent, from diseases of the circulatory system. Tuberculosis thus led heart disease slightly for April.

Other notable causes of death were: Diseases of the nervous system, 337; violence, 329; diseases of respiratory system, 289; diseases of digestive system, 271; cancer, 238; Bright's disease and nephritis, 209; and epidemic diseases, 128.

The deaths from epidemic diseases were as follows: Measles, 29; typhoid fever, 23; diphtheria and croup, 22; influenza, also 22; whooping-cough, 9; scarlet fever, 8; and all other epidemic diseases, 15.

The deaths from the four leading epidemic diseases reported for the month were distributed by counties as follows:

Measles.	
Imperial	3
Kern	2
Los Angeles	17
San Diego	1
San Francisco	1
Santa Clara	2
Solano	1
Tulare	2
Total	29

Diphtheria and croup.	
Alameda	1
Butte	1
Los Angeles	10
Sacramento	2
San Bernardino	1
San Francisco	4
Santa Clara	1
Solano	2
Total	22

Typhoid fever.	
Alameda	3
Contra Costa	1
Kings	1
Los Angeles	1
Madera	1
Monterey	1
Orange	1
Riverside	3
Sacramento	3
San Bernardino	1
San Diego	1
San Francisco	4
Solano	1
Stanislaus	1
Total	23

Influenza.	
Alameda	3
Butte	2
El Dorado	2
Kings	1
Los Angeles	7
Monterey	1
San Bernardino	1
San Francisco	2
Santa Clara	1
Solano	1
Sonoma	1
Total	22

Geographic Divisions.—The following table presents data for geographic divisions, including the metropolitan area, or San Francisco and the other bay counties (Alameda, Contra Costa, Marin, and San Mateo), in comparison with the rural counties of Northern and Central California:

Deaths from Main Classes of Diseases, from Geographic Divisions: April.

Geographic division.	Deaths: April.										
	All causes	Epidemic diseases	Tuberculosis (all forms)	Cancer	Diseases of nervous system	Diseases of circulatory system	Diseases of respiratory system	Diseases of digestive system	Bright's disease and nephritis	Violence	All other causes
THE STATE	3,235	128	493	238	337	486	289	271	209	329	455
Northern California	343	13	39	21	33	58	33	25	27	31	63
Coast counties	175	6	22	13	13	30	17	14	13	12	35
Interior counties	168	7	17	8	20	28	16	11	14	19	28
Central California	1,678	57	220	143	181	284	149	158	98	170	218
San Francisco	611	16	76	46	56	130	54	58	37	51	87
Other bay counties	384	8	60	42	38	50	38	31	22	47	48
Coast counties	190	6	15	19	35	38	13	14	14	15	21
Interior counties	493	27	69	36	52	66	44	55	25	57	62
Southern California	1,214	58	234	74	123	144	107	88	84	128	174
Los Angeles	835	43	161	53	85	89	79	57	61	70	137
Other counties	379	15	73	21	38	55	28	31	23	58	37
Northern and Central California	2,021	70	259	164	214	342	182	183	125	201	281
Metropolitan area	995	24	136	88	94	180	92	89	59	98	135
Rural counties	1,026	46	123	76	120	162	90	94	66	103	146

Sex and Age Periods.—The proportion of the sexes among the 3,235 decedents in April was: Male, 2,008, or 62.1 per cent, and female, 1,227, or 37.9 per cent.

The following table shows the age distribution by numbers and per cents, of deaths classified by sex:

Deaths Classified by Sex and Age Periods, with Per Cents by Age Periods, for California: April.

Age period.	Deaths.			Per cent.		
	Total.	Male.	Female.	Total.	Male.	Female.
ALL AGES	3,235	2,008	1,227	100.0	100.0	100.0
Under 1 year	329	190	139	10.2	9.5	11.3
1 to 4 years	147	79	68	4.5	3.9	5.5
5 to 14 years	96	52	44	3.0	2.6	3.6
15 to 24 years	198	114	84	6.1	5.7	6.8
25 to 34 years	298	191	107	9.2	9.5	8.7
35 to 44 years	372	246	126	11.5	12.2	10.3
45 to 54 years	401	281	120	12.4	14.0	9.8
55 to 64 years	420	273	147	13.0	13.6	12.0
65 years and over	974	582	392	30.1	29.0	32.0

This table shows that relatively more females than males died at the age periods under 25 years as well as at 65 years and over, while relatively more males than females died at the age periods from 25 to 64 years.

Occupations.—The table below gives, for deaths 15 years and over, the number of men and women for whom such occupation was reported in contrast with those for whom no gainful occupation was shown.

Deaths, 15 Years and Over, Classified by Sex and Occupation, with Per Cents by Sex, for California: April.

	Deaths.			Per cent male.	Per cent female.
	Total.	Male.	Female.		
15 YEARS AND OVER	2,663	1,687	976	63.3	36.7
Occupation reported	1,553	1,455	98	93.7	6.3
No gainful occupation	1,110	232	878	20.9	79.1

Of the 1,553 decedents for whom occupations were reported the males numbered 1,455, or 93.7 per cent, and the females only 98, or 6.3 per cent.

The following table shows the distribution of male decedents 15 years and over, engaged in the main kinds of occupation:

Deaths of Males Fifteen Years and Over Engaged in Gainful Occupations, Classified by Kind of Occupation, with Per Cents, for California: April.

Kind of occupation.	Males 15 years and over.	
	Deaths.	Per cent.
ALL OCCUPATIONS	1,455	100.0
Professional	80	5.5
Clerical and official	121	8.3
Mercantile and trading	101	6.9
Public entertainment	31	2.1
Personal service, police and military	53	3.7
Laboring and servant	298	20.5
Manufacturing and mechanical industry	300	20.6
Agriculture, transportation and other outdoor pursuits	463	31.8
All other occupations	8	0.6

Of the 1,455 male decedents for whom occupations were reported, 463, or 31.8 per cent, were engaged in agriculture, transportation, and other outdoor pursuits; 300, or 20.6 per cent, in manufacturing and mechanical industry; 298, or 20.5 per cent, in laboring and servant work; and altogether 394, or 27.1 per cent, in professional, clerical and official, mercantile and trading, and all other occupations.

It should be noted that the figures on deaths occurring in different occupations are necessarily affected by the fact that in California a large number of men are engaged in agriculture and other outdoor pursuits, while relatively few follow professional and similar occupations which show small numbers of deaths.

REPORT OF THE BUREAU OF THE HYGIENIC LABORATORY FOR MAY.

WILBUR A. SAWYER, M.D., Director.

Failure to Take Diphtheria Cultures.

Occasionally a child, who would have been saved by antitoxin, dies from diphtheria in California because the disease did not present early symptoms which were characteristic enough to establish the correct diagnosis. Sometimes an accompanying skin eruption leads to a mistaken diagnosis of scarlet fever and the throat condition is regarded as the sore throat which is usually a part of that disease. Sometimes scarlet fever and diphtheria exist in the same patient and the diphtheria is overlooked. Not infrequently diphtheria starts in the nose or the larynx where it cannot readily be seen and the disease is not discovered in time. In all cases of doubt, physicians should supplement the physical examination of the patient with a laboratory test of a culture from the throat and nose. In case of serious illness where diphtheria is suspected antitoxin should be administered without waiting for the report from the laboratory. Few persons will die of diphtheria owing to a mistake in diagnosis if cultures are promptly taken in all cases of serious doubt. The importance of these measures is recognized by the provisions of the State Board of Health and the larger cities of California for the free examination of diphtheria cultures. The State Hygienic Laboratory has established 159 depositories for the storage and free distribution to physicians of diphtheria culture outfits, so that there is little need for delay in taking cultures.

Division of Biological Examinations.

Summary of Examinations Made in the California State Hygienic Laboratory During the Month of May, 1913.

Condition suspected.	Positive.	Negative.	Inconclusive.	Total.
Main Laboratory at Berkeley:				
Anthrax		3		3
Diphtheria	8	29	1	38
Gonococcus infection	10	5		15
Malaria		4		4
Meningitis, epidemic	2			2
Rabies	22	4	3	29
Tuberculosis	19	14		33
Typhoid	7	10		17
Water pollution	1	2		3
				144
Northern Branch at Sacramento:				
Diphtheria	11	24	3	38
Gonococcus infection	1			1
Malaria	1	3		4
Tuberculosis	4	7		11
Typhoid	1	7		8
				62
San Joaquin Valley Branch at Fresno:				
Diphtheria		3		3
Tuberculosis	1	2		3
Typhoid		6		6
				12
Southern Branch at Los Angeles:				
Diphtheria	5	8		13
Rabies	1			1
Typhoid	2	9		11
				25
Total number of examinations				243

Division of Preventive Therapeutics.

Pasteur Treatment for the Prevention of Rabies by the State Hygienic Laboratory During the Month of May, 1913.

	Treatment commenced.	Treatment completed.
Main Laboratory at Berkeley	2	3
Northern Branch at Sacramento	1	2
San Joaquin Valley Branch at Fresno	0	0
Southern Branch at Los Angeles	0	0
Laboratory of Sacramento Board of Health, by deputized bacteriologist	0	0
Laboratory of San Francisco Board of Health, by deputized bacteriologist	5	6
Laboratory of Los Angeles Board of Health, by deputized bacteriologist	1	0
Laboratory of Letterman General Hospital, Presidio, by deputized bacteriologist	0	0
	9	11

Public Health Instruction.

Participation in Instruction in Public Health During May, 1913.

Main Laboratory at Berkeley:	
Bacteriological instruction outfits sent out	7
Bacteriological instruction outfits in use	32
Lectures or talks by the director	0
Lectures or talks by the chief bacteriologist	1

Division of Epidemiological Investigations.

Epidemiological Investigations During May, 1913.

Main Laboratory at Berkeley:	
Special investigations by the director	6
Continuation of the investigation into the methods of spread of epidemic poliomyelitis.	
Continuation of an investigation into the methods of sterilization of library books.	
Continuation of an investigation into the bactericidal efficiency of "Ozone" machines.	
Investigation at Lakeport of cases of diphtheria and suspected scarlet fever.	
Investigation at Walnut Creek of cases of smallpox.	
Investigation of two human cases of rabies in San Francisco.	
Special investigations by the assistant bacteriologist	1
Completion of the study of the virulence of diphtheria bacilli isolated from the throats of carriers.	

REPORT OF BUREAU OF FOOD AND DRUGS FOR MAY, 1913.

M. E. Jaffa, Director.

The samples received at the Food and Drug Laboratory, during the month of May, include the usual miscellaneous official samples collected by inspectors, samples from state institutions examined to ascertain their conformity to contract specifications, and several samples of waste products from manufacturing establishments which were analyzed for the California Fish and Game Commission in connection with their enforcement of the state law which prohibits the discharge of certain materials into the waters of the bay.

A number of samples of gluten bread, representing several brands found in the open market, recently received at the Laboratory have been found deficient in gluten. These samples were made from a mixture of gluten flour and common flour, in some cases in such proportions that the bread was but very little stronger in gluten than ordinary bread. Gluten bread should be made from GLUTEN FLOUR, the standard for which is as follows:

> ''Gluten flour is the clean, sound product made from flour by the removal of the starch and contains not less than five and six tenths per cent (5.6%) of nitrogen and not more than ten per cent (10%) of moisture.''

The standard for common FLOUR reads:

> ''Flour is the fine, clean, sound product made by bolting wheat meal and contains not more than thirteen and five tenths per cent (13.5%) of moisture, not less than one and twenty-five hundredths per cent (1.25%) of nitrogen, not more than one per cent (1%) of ash, and not more than fifty one-hundredths per cent (.50%) of fibre.

Any person wishing copies of the following Notices of Judgment may obtain same by addressing the Director of the State Food and Drug Laboratory, University of California, Berkeley, Cal.:

Nos. 2216 to 2219 incl., 2259 to 2264 incl., 2266 to 2293 incl., 2297—Adulteration of Milk.
Nos. 2220, 2236—Adulteration and Misbranding of Vinegar.
No. 2221—Adulteration and Misbranding of Blackberry Cordial.
No. 2222—Misbranding of Bitters.
No. 2223—Adulteration of Raspberries.
No. 2224—Adulteration of Mineral Water.
Nos. 2225, 2226, 2228, 2230, 2232, 2234, 2252, 2254, 2256—Misbranding of Vodka.
Nos. 2227, 2229—Adulteration and Misbranding of Beer.
No. 2231—Misbranding and Adulteration of Syrup.
Nos. 2233, 2322—Adulteration of Tomato Pulp.
No. 2235—Adulteration and Misbranding of Malt Tonic.
No. 2237—Misbranding of Vanilla Extract.
No. 2238—Alleged Misbranding of Italian Chocolates.
No. 2239—Adulteration and Misbranding of Honey Gin and Orange.
Nos. 2240, 2315—Misbranding of Flour.
No. 2241—Adulteration and Misbranding of Vanilla Flavor (Bakers), Ginger Extract (Jamaica), Vanilla Extract (Special A), Cassia Extract, Vanilla Extract (Boston), Lemon Extract (Bakers), and Vanilla Extract (Superior Ice Cream); and Misbranding of Pistachio Extract.
No. 2242—Adulteration and Misbranding of Wintergreen Extract.
No. 2243—Adulteration and Misbranding of Blood Orange Extract and of Orange Extracts.
No. 2244—Adulteration and Misbranding of Nutmeg Extract.
Nos. 2245, 2300—Adulteration and Misbranding of Canned Tomatoes.
No. 2246—Misbranding of So-called Red Dragon Seltzer.
No. 2247—Adulteration and Misbranding of Eggs.
Nos. 2248, 2320—Adulteration and Misbranding of Lemon Extract.
No. 2249—Adulteration of Oysters.
No. 2250—Misbranding of Coffee.
No. 2251—Adulteration and Misbranding of Sardines.
No. 2253—Adulteration and Misbranding of So-called Apple Brandy.
No. 2255—Misbranding of Canned Blueberries.
Nos. 2257, 2311, 2312—Adulteration of Tomato Catsup.
No. 2258—Misbranding of Malt Extract.
Nos. 2265, 2302, 2303—Adulteration of Cream.
No. 2294—Adulteration of Prunes.
No. 2295—Adulteration of Gelatin.
No. 2296—Adulteration of Apricots.
No. 2298—Adulteration and Misbranding of Essence of Peppermint.
Nos. 2299, 2306—Adulteration and Misbranding of Nitroglycerin Tablets.

REPORT OF THE BUREAU OF PUBLICATIONS AND HEALTH INFORMATION FOR MAY, 1913.

GUY P. JONES, Acting Director.

Coincidental with the adjournment of the legislature, this Bureau was flooded with requests for copies of bills pertaining to health legislation that passed both houses. It was impossible to comply with all of the requests, because the continuous and unprecedented demand for these bills since the beginning of the session in January had almost exhausted the supply.

However, the Board expects to publish a new pamphlet edition of the State Health Laws, including those measures which shall become law during the present year. Names of all who request that this pamphlet be sent to them, will be filed, and immediately upon publication a copy will be forwarded.

A new revised edition of the Pure Food and Drug Laws for California is also planned to be published during the summer. This will contain the legislation pertaining to foods and drugs enacted by the 1913 legislature. Requests for copies of the publication should be sent to this Bureau.